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(54) **LIQUID CONTAINER LID AND APPARATUS AND METHODS OF USE**

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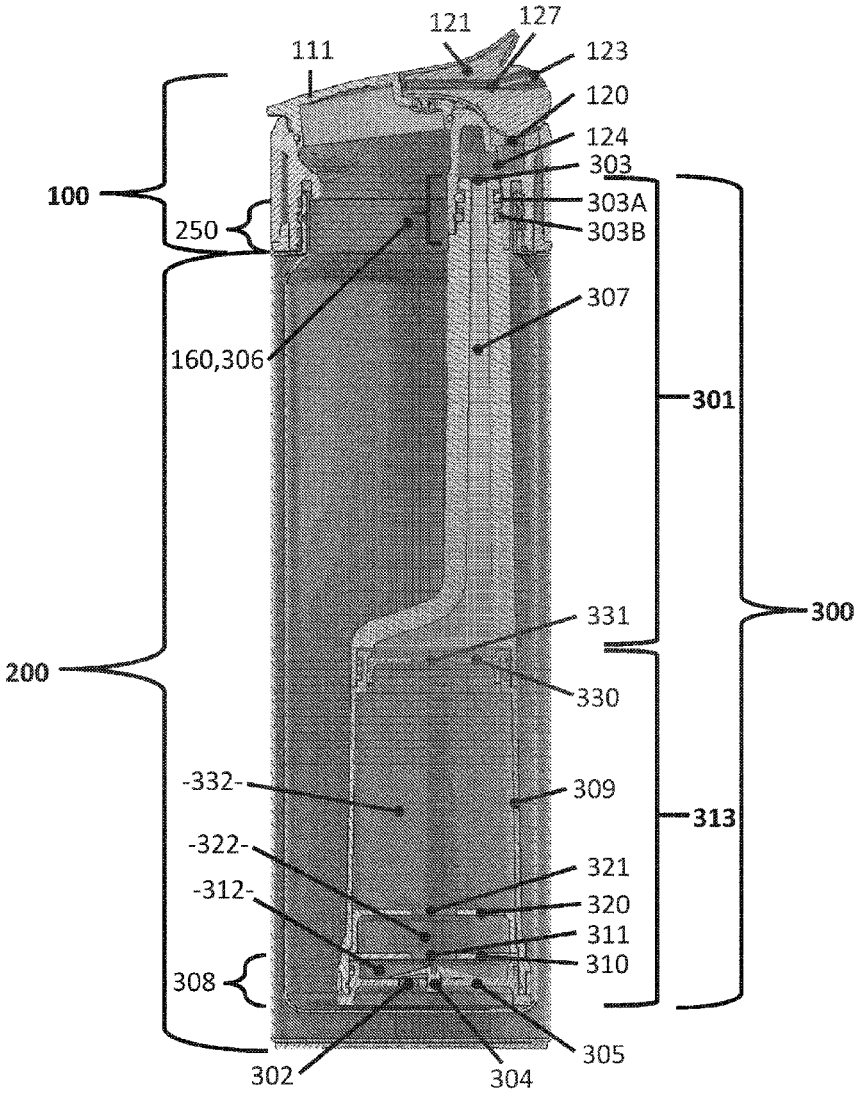
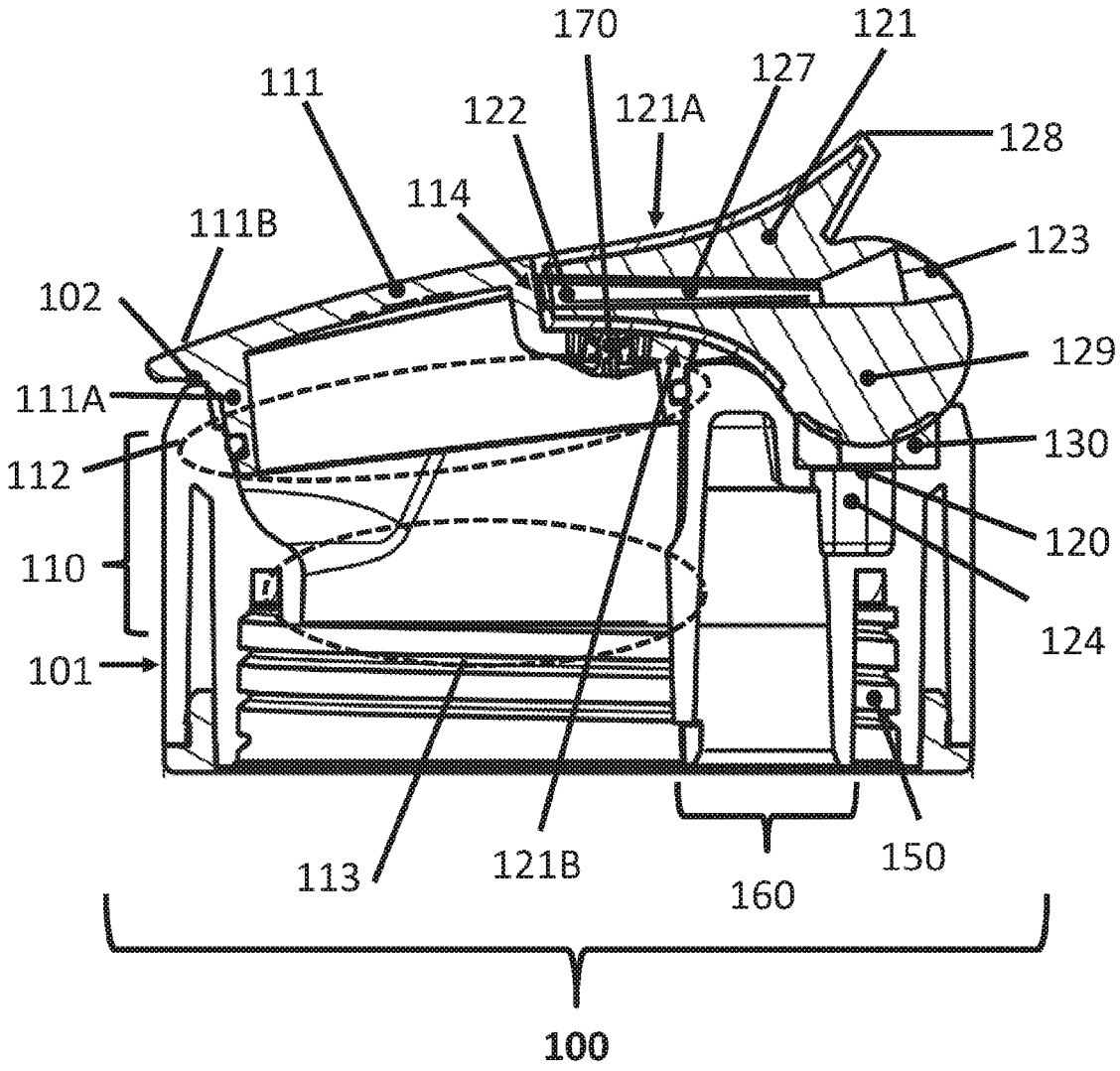
(57) **ABSTRACT**

Aspects of the present disclosure are directed to liquid containers and liquid container lids and/or filters. Some embodiments of the present disclosure relate to liquid container lids having a filling aperture and/or a drinking aperture.




170
121
127
111
122
121A
128
114
111B
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102
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111A
130
112
120
110
124
101
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121B
150
160
100

FIG. 1

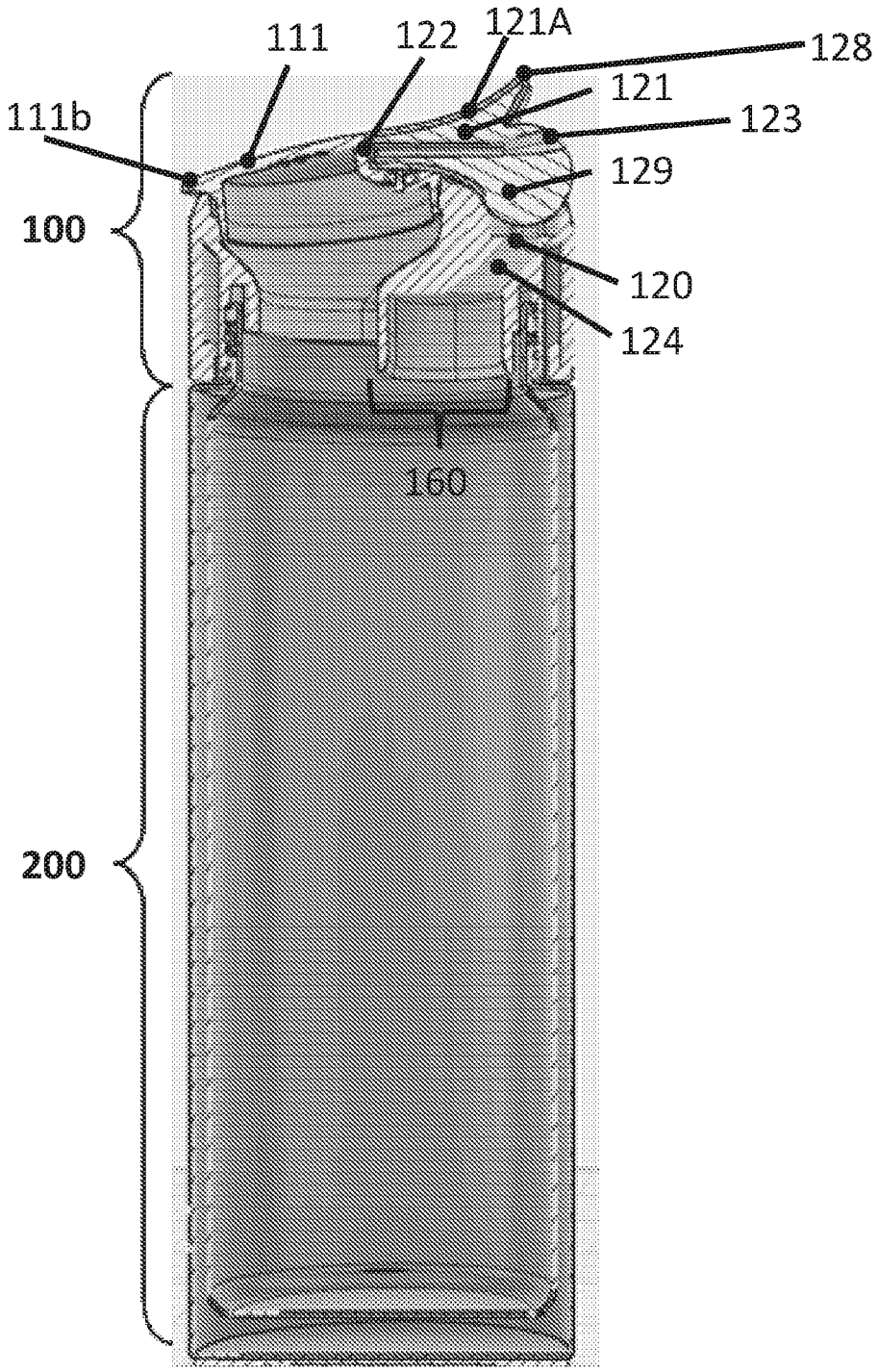


FIG. 2

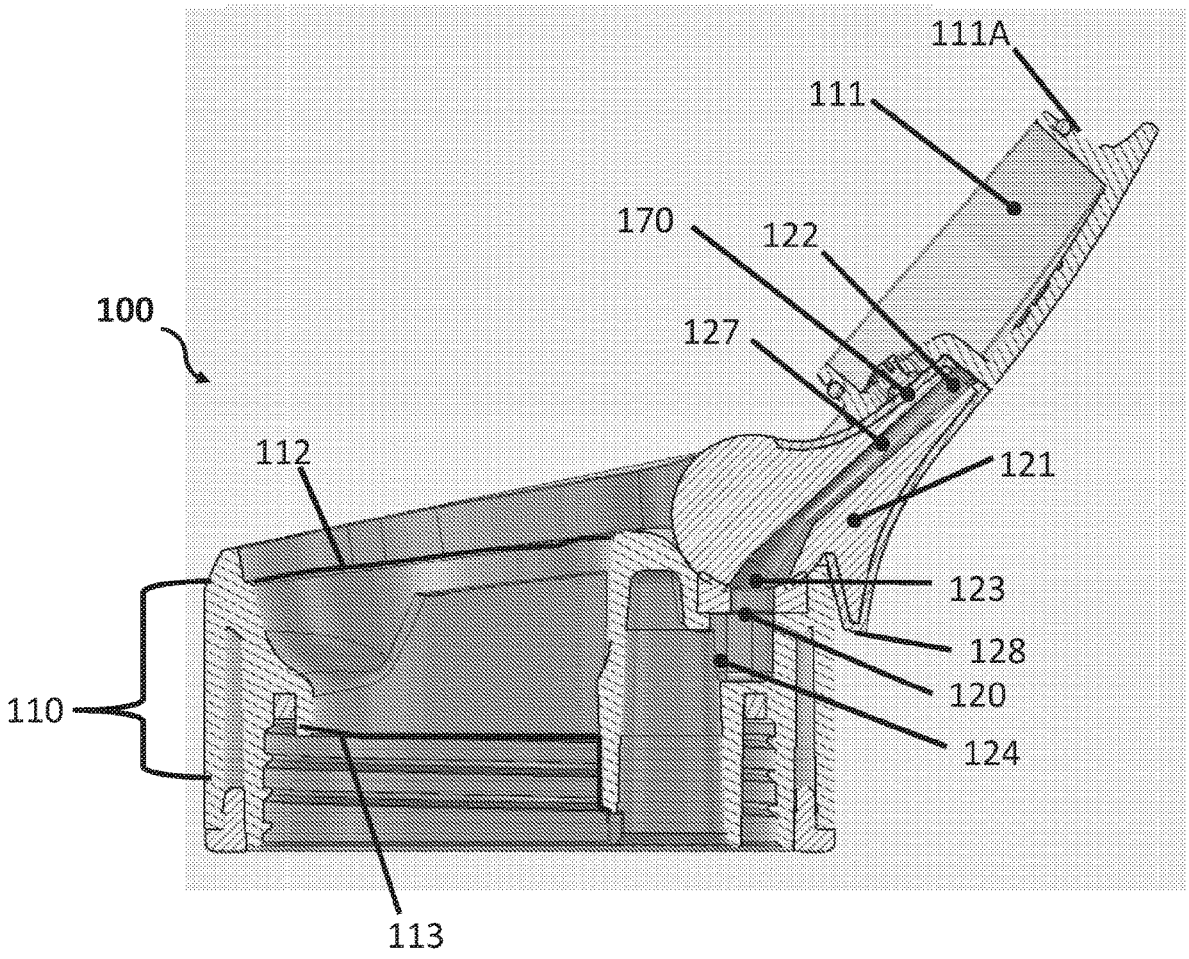


FIG. 3

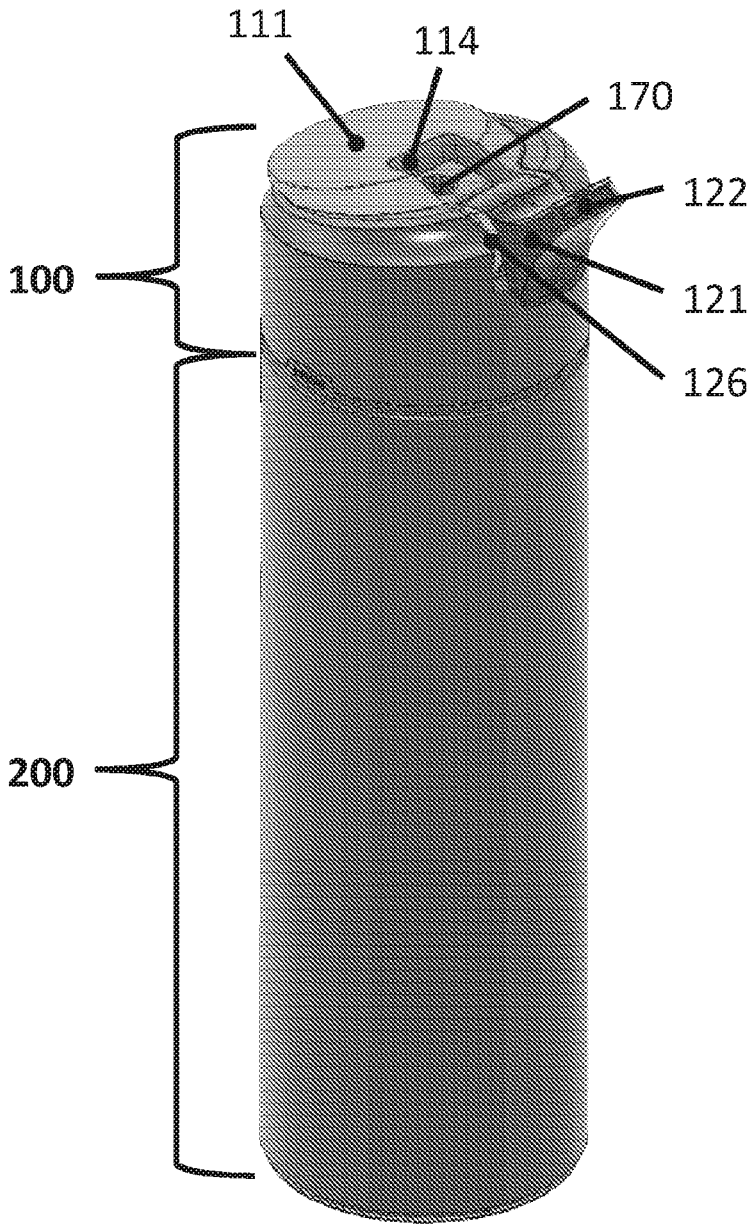


FIG. 4

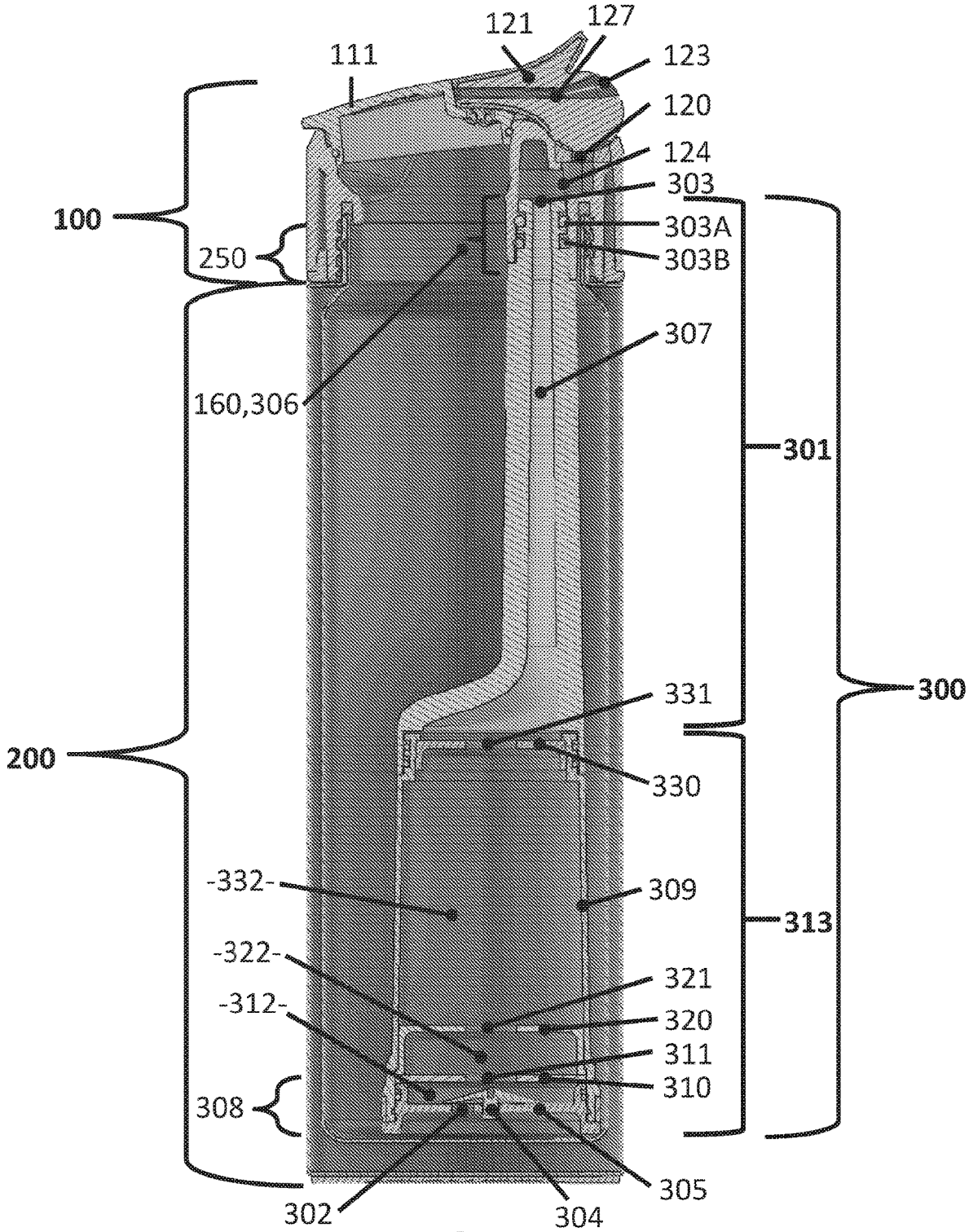

121
127
111
123
120
124
303
100
303A
250
303B
307
160,306
301
331
300
200
330
-332-
309
313
-322-
321
-312-
320
311
308
310
305
302
304

FIG. 5A

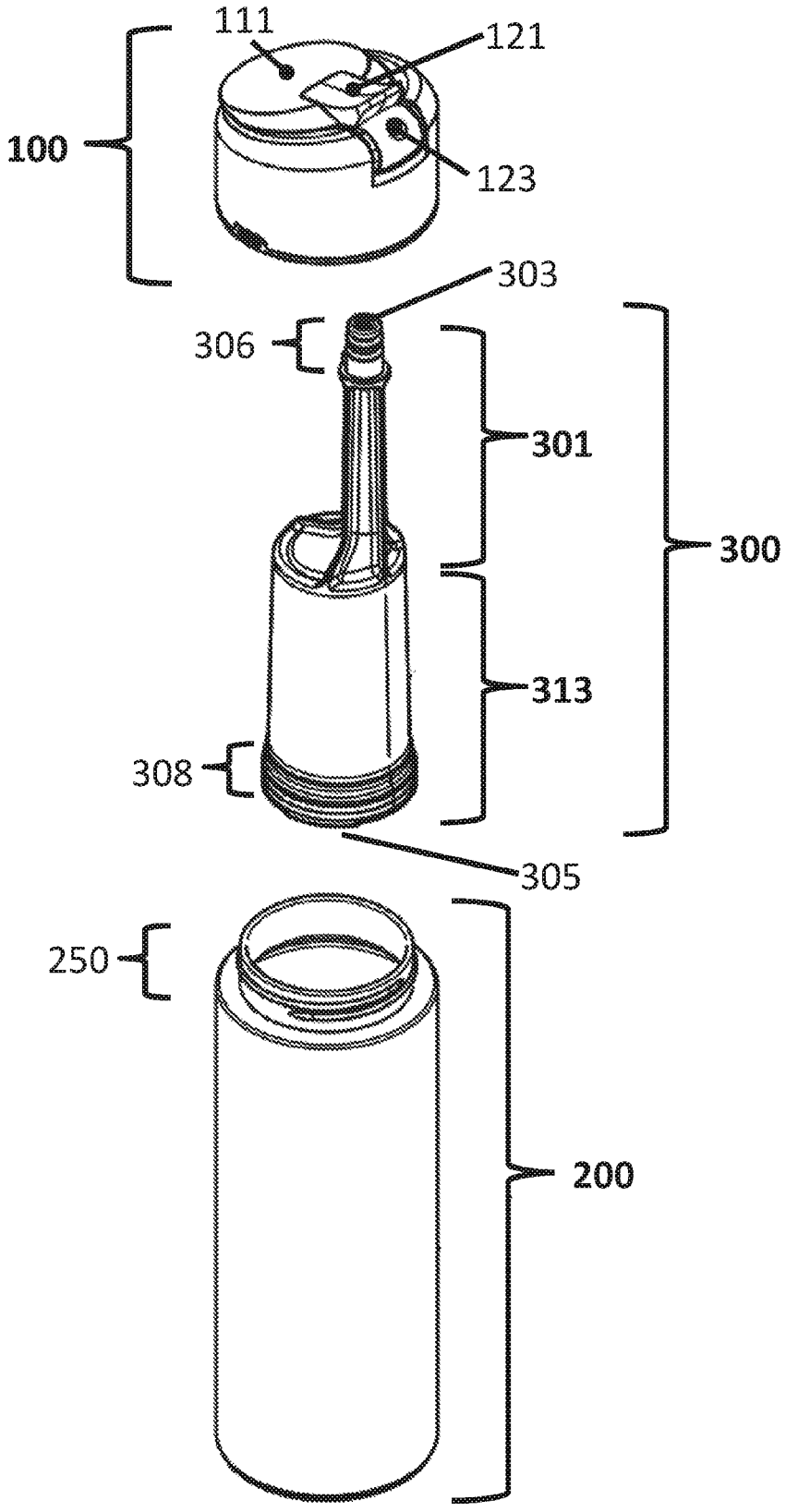
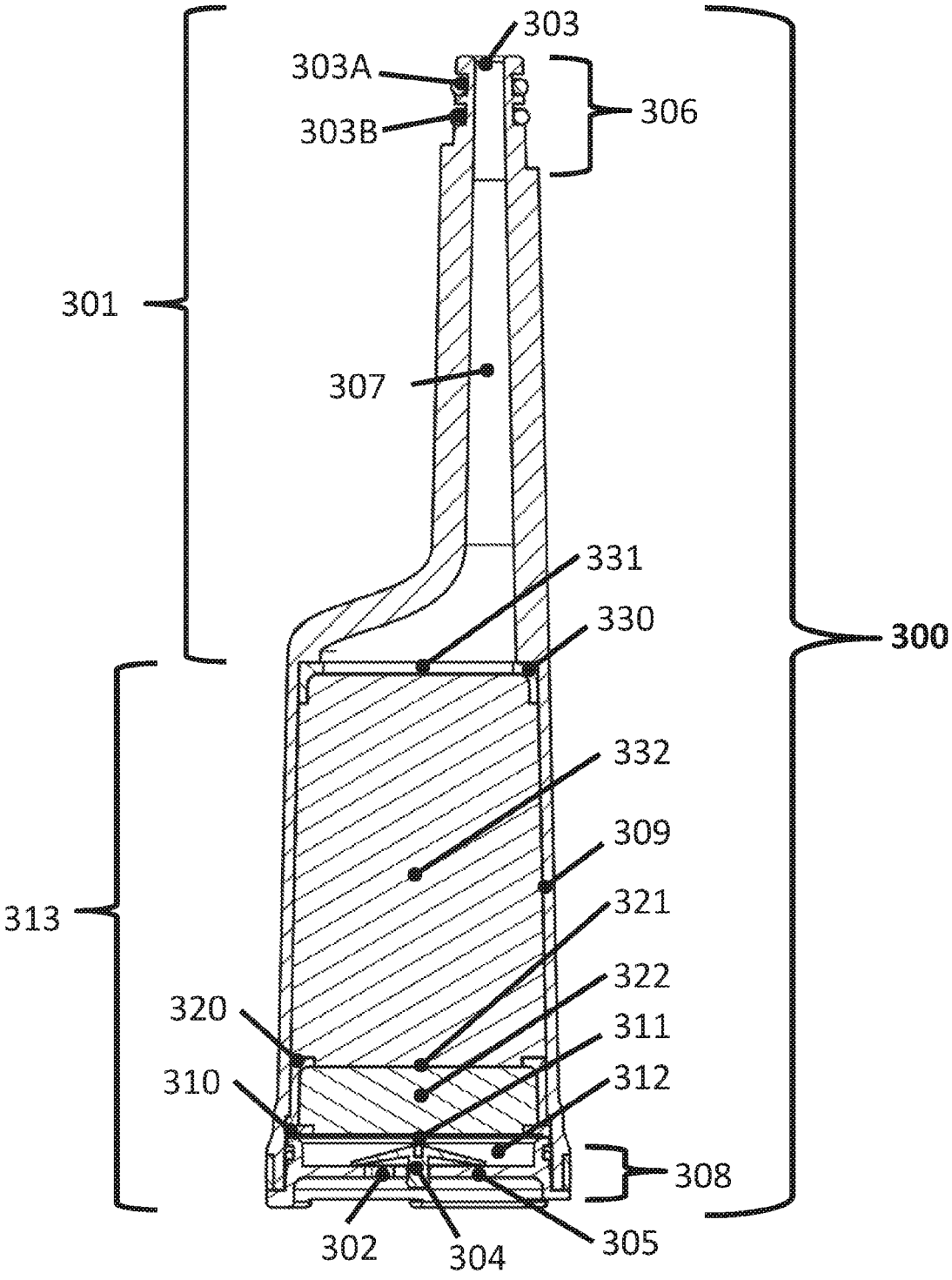


FIG. 5B


303
303A
303B
306
301
307
331
330
300
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309
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302
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305

FIG. 5C

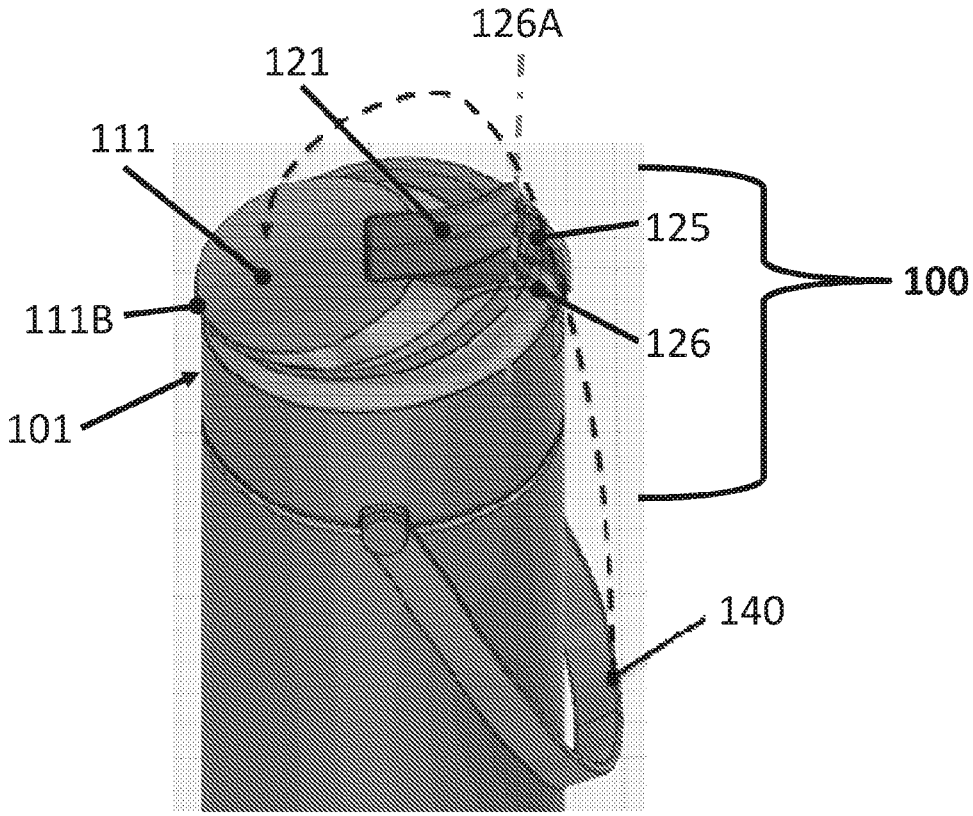

FIG. 6

FIG. 7

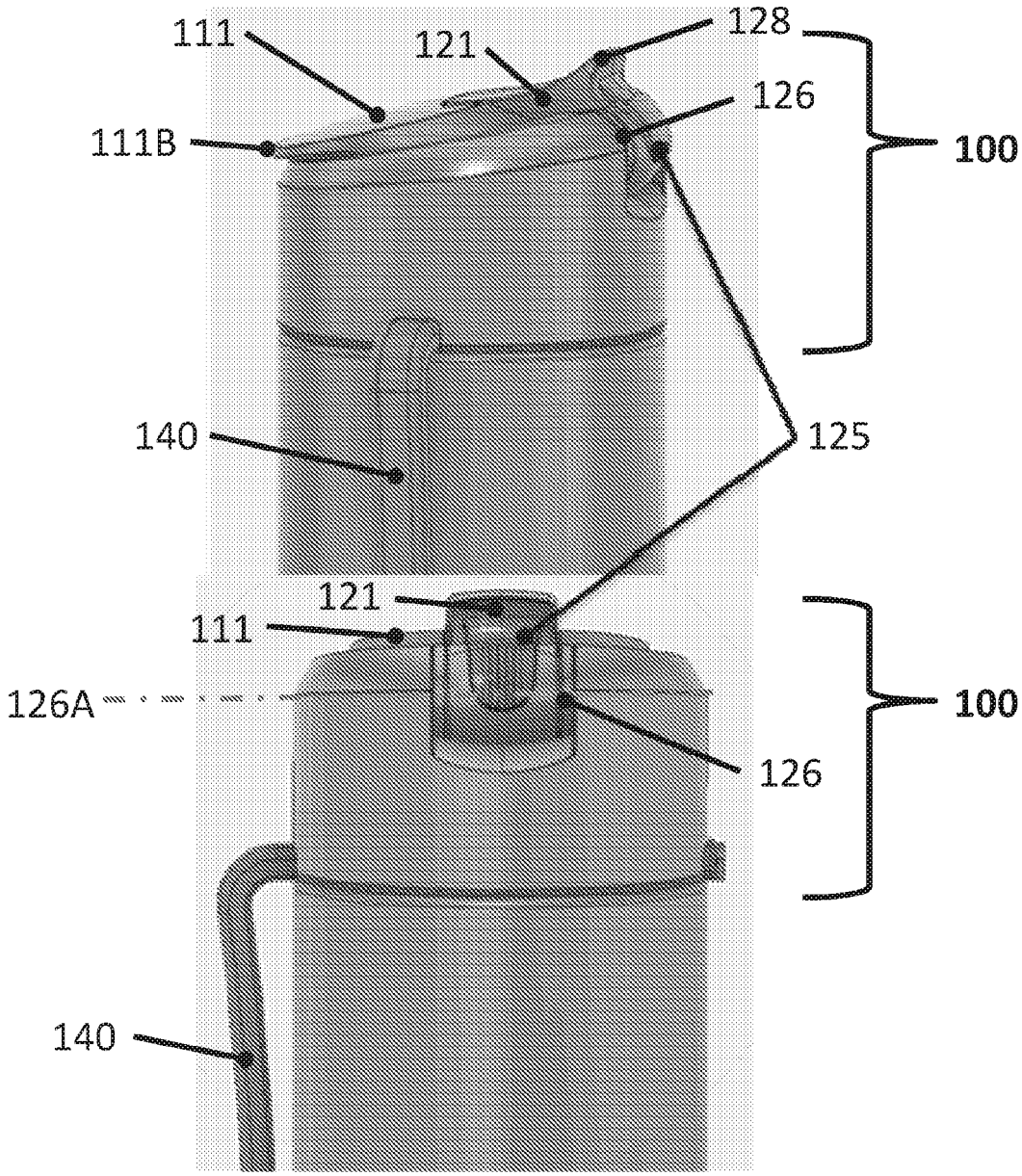

FIG. 8

LIQUID CONTAINER LID AND APPARATUS AND METHODS OF USE

BACKGROUND

Field of the Development

[0001] Aspects of the present disclosure are directed to the field of liquid containers and liquid container lids. More specifically, the present disclosure relates to liquid container lids having a filling aperture and a drinking aperture.

Description of the Related Art

[0002] Beverage containers are ubiquitous for the storage and transportation of liquids, such as water, juice, coffee, and tea. Traditional beverage containers include a removable lid that covers the beverage container and provides a drinking aperture. Common drinking apertures include a sipping interface (e.g., an opening for sipping the contained beverage) or a suction interface (e.g., mouthpiece-type beverage container lids configured to draw up the contained beverage through suction generated by a user). Such lids engage the beverage container through a threaded or rotatable engagement, snap-fit, friction fit, mechanical interlock, male-female connector, or other suitable removable connection mechanism.

[0003] Mouthpiece-type beverage container lids have become increasingly popular in recent years. These beverage container lids include an articulable mouthpiece that moves between a closed (e.g., folded) position and an open (e.g., unfolded) position, to respectively deny or allow a user to access the contents of the beverage container. Accordingly, in the open position, the mouthpiece of these beverage container lids is in selectable fluid communication with the contents of the beverage container, and vice versa. Furthermore, such mouthpiece-type beverage container lids often include one or more vent orifices to allow ambient air to enter the beverage container to minimize suction forces in the container and facilitate drinking.

[0004] Ultimately, traditional beverage container lids are inadequate for several reasons. For example, mouthpiece-type beverage container lids typically lack an aperture usable to refill the beverage container. Consequently, users must generally remove traditional beverage container lids from the beverage container in order to refill the beverage container. Having to repetitively remove and replace the lid with each refill of the beverage container causes inconvenience to the user and increases the exposure of the beverage container lid interior and the beverage container interior to contaminants and pollutants.

[0005] Prior beverage container lids also suffer from additional hygienic concerns. For instance, most beverage container lids lack a filter arrangement for decontaminating, disinfecting, or otherwise purifying the liquid in the beverage container prior to the consumption of the liquid. In those lids that include a filter arrangement, the filter displacement volume often causes the beverage container to overflow when attaching the lid to a refilled beverage container. As a result, users of prior filtered beverage container lids must intentionally under-fill the beverage container to account for the filter displacement volume. Further, traditional mouthpiece-type beverage container lids expose the opening at the base of the mouthpiece to the environment when the mouthpiece is in the closed position. Similarly, these beverage container lids may have no structure for sealing or protecting the drinking tip of the mouthpiece in the closed position (i.e., when the mouthpiece is not in use). As such, prior mouthpiece-type beverage container lids may offer no or little protection against contaminants or pollutants entering the drinking tip or base opening of the mouthpiece when in the closed position.

[0006] Accordingly, there is a need for an improved beverage container lid that allows refilling of the beverage container without removing the lid while addressing the hygienic concerns raised by existing beverage container lids.

SUMMARY

[0007] In some embodiments, a liquid container lid is provided. The liquid container lid comprises a filling aperture configured to allow liquid to enter therethrough; and a drinking aperture configured to allow liquid to exit therethrough. The cap can be configured to removably sealingly engage the filling aperture. The liquid container lid further includes a mouthpiece hingedly engaged with the cap, the mouthpiece having a tip in selectable fluid communication with the drinking aperture. The mouthpiece is movable relative to the cap from a closed position to an open position.

[0008] In some embodiments, a filter assembly for use with a liquid container is provided. The filter assembly comprises a housing having an inlet and an outlet, the housing including a housing base and at least one filter wall, wherein at least one filter compartment is defined within the housing. One or more of the inlet and outlet are configured to removably attach to a lid of the liquid container. The lid of the liquid container is configured to allow a user to draw water through the filter and out of an aperture in the lid of the liquid container. The filter compartment is configured to house at least one filter media.

BRIEF DESCRIPTION OF THE DRAWINGS

[0009] FIG. **1** is a cross-sectional view of one embodiment of a beverage container lid.

[0010] FIG. **2** is a cross-sectional view of the beverage container lid of FIG. **1**, in addition to a beverage container.

[0011] FIG. **3** is a cross-sectional view of the beverage container lid of FIG. **1**, with a cap in an open position.

[0012] FIG. **4** is a perspective view beverage container lid of FIG. **1**, with a mouthpiece in an open position.

[0013] FIG. **5**A is a cross-sectional view of the beverage container lid of FIG. **2**, including a filter arrangement.

[0014] FIG. **5**B is an exploded depiction of some embodiments.

[0015] FIG. **5**C is a depiction of the filter assembly and functional module in greater detail.

[0016] FIG. **6** is a perspective view of the beverage container lid of FIG. **2**.

[0017] FIG. **7** is a left side view of the beverage container lid of FIG. **1**.

[0018] FIG. **8** is a front side view of the beverage container lid of FIG. **1**.

DETAILED DESCRIPTION

[0019] FIGS. **1-8** depict an embodiment of a beverage container lid **100** for use in storing a volume of liquid within a beverage container **200**. The beverage container **200** can be used with any kind of liquid; one non-limiting example of liquids includes potable liquids such as beverages. As

used herein, the term "beverage" includes water and other drinks. FIGS. **1-3** and FIGS. **5**A and **5**B provide a cross-sectional view of the beverage container lid **100**, which includes a filling aperture **110**, a drinking aperture **120**, a cap **111**, and a mouthpiece **121**, among other features. As is illustrated in FIG. **2**, the beverage container lid **100** may be removably connected to a beverage container **200** through a threaded or rotatable engagement, snap-fit, friction fit, mechanical interlock, or other suitable removable connection mechanism between the beverage container **200** and lid **100**. Optionally, a threaded connection region **150** that is disposed along the bottom of the beverage container lid **100** may removably connect with a corresponding connection region **250** disposed along an outer periphery of the beverage container **200**.

[0020] In some embodiments, the lid, container, filter assembly, and/or functional module can be combined as a single arrangement. In other embodiments, one or two, or three of the components can be sold or used or combined together as subparts. In some embodiments, one or two or three or all four of the parts can be combined with other drinking systems and/or methods and/or kits. In some embodiments, the cap is hingedly engaged with the lid. In some embodiments, opening the cap correspondingly moves the mouthpiece (and the device is configured in such an arrangement).

[0021] In some embodiments, a lid is provided. The lid can comprise a filling aperture configured to allow liquid to enter therethrough; and a drinking aperture configured to allow liquid to exit therethrough. The cap can be configured to removably sealingly engage the filling aperture. The liquid container lid further includes a mouthpiece hingedly engaged with the cap, the mouthpiece having a tip in selectable fluid communication with the drinking aperture. The mouthpiece is movable relative to the cap from a closed position to an open position.

[0022] In some embodiments, a filter assembly for use with a liquid container is provided. The filter assembly comprises a housing having an inlet and an outlet, the housing including a housing base and at least one filter wall, wherein at least one filter compartment is defined within the housing. One or more of the inlet and outlet are configured to removably attach to a lid of the liquid container. The lid of the liquid container is configured to allow a user to draw water through the filter and out of an aperture in the lid of the liquid container. The filter compartment is configured to house at least one filter media.

[0023] As is illustrated in FIG. **1**, the mouthpiece **121** may comprise a tip opening **122** in fluid communication with a base opening **123**, such that a drinking channel **127** is defined between the tip opening **122** and base opening **123**. The mouthpiece **121** may have a thickness defined as the distance between the top surface **121**A and bottom surface **121**B of the mouthpiece. The thickness of the mouthpiece **121** may increase with increasing distance from the tip opening **122**, although the thickness may also be uniform along the length of the mouthpiece **121**. The mouthpiece **121** may also include a projection **128** that extends from the top surface **121**A to facilitate opening and closing of the mouthpiece **121** by a user.

[0024] The mouthpiece **121** can be moved relative to the beverage container lid **100** between a closed position, a semi-closed position, and an open position. This movable arrangement of the mouthpiece **121** relative to the beverage container lid **100** may be achieved by a hinge **126**. The mouthpiece **121** may be directly or indirectly connected with the hinge **126**, which allows the mouthpiece **121** to pivot or rotate around the hinge axis **126**A between the closed and open positions, as desired by the user.

[0025] The tip opening **122** of the mouthpiece **121** may be in selectable fluid communication with liquid inside the optional beverage container **200**. For example, in the closed position, the tip opening **122**, base opening **123**, and drinking channel **127** of the mouthpiece **121** are not in fluid communication with the drinking aperture **120** and delivery channel **124**, as is illustrated in FIG. **1**. In the semi-closed position, the mouthpiece **121** is partially rotated around the hinge axis **126**A, but the tip opening **122**, base opening **123**, and drinking channel **127** of the mouthpiece **121** are not in fluid communication with the drinking aperture **120** and delivery channel **124**. In the open position, however, the mouthpiece **121** is fully rotated around the hinge axis **126**A, and the tip opening **122**, base opening **123**, and drinking channel **127** of the mouthpiece **121** are in fluid communication with the drinking aperture **120** and the delivery channel **124**. The drinking aperture **120** and/or delivery channel **124** may be in fluid communication with a straw or other conduit structure that extends from the beverage container lid **100** into the optional beverage container **200**. Accordingly, in the open position, user-generated suction at the tip opening **122** of the mouthpiece **121** may draw liquid from the beverage container **200** and into the user's mouth.

[0026] FIGS. **6-8** illustrate that the beverage container lid **100** optionally includes a base opening cover **125** that covers the base opening **123** of the mouthpiece **121** when the mouthpiece **121** is in the closed position. The mouthpiece **121** may comprise the base opening cover **125**, which may extend downwardly from the projection **128** to cover the base opening **123**. Optionally, the base opening cover **125** may extend upwardly from the beverage container lid **100** to cover the base opening **123** when the mouthpiece **121** is in the closed position. The base opening cover **125** may be shaped to surround the base opening **123**. Advantageously, the base opening cover **125** prevents contaminants and other hygienic concerns (e.g., dust, insects, etc.) from entering the base opening **123** when the mouthpiece **121** is in the closed position.

[0027] The base opening cover **125** may be formed of a resilient polymeric or other suitable flexible material that is capable of deflecting out of the way of the base opening **123** when the mouthpiece **121** is moved to the open position. Optionally, the base opening cover **125** may be formed of a more rigid material, provided that the material still allows the base opening cover **125** to deflect and permit fluid communication between the base opening **123** and drinking aperture **120** when the mouthpiece **121** is in the open position. Additionally, if it extends upwardly from the beverage container lid **100**, the base opening cover **125** may be formed of a more rigid material because the need for the base opening **125** to deflect may be reduced or eliminated entirely.

[0028] In the closed or semi-closed position, a sealing portion **129** along the bottom surface **121**A of the mouthpiece **121** prevents liquid from escaping through the drinking aperture **120**. For example, the sealing portion **129** may engage and seal against the thinking aperture **120** or drinking aperture walls **130** that extend upward from the drinking aperture **120**, thereby preventing liquid from escaping

through the beverage container lid **100** via the drinking aperture **120**. As discussed below, the sealing portion **129** of the mouthpiece **121** may be formed of a resilient material that can compress against the drinking aperture **120** and/or drinking aperture walls **130** to create a conforming seal. Additionally, rotation of the mouthpiece **121** from the open position to the closed position eliminates any user-generated suction in the drinking Channel **127** of the mouthpiece **121**, which helps prevent liquid from escaping through the drinking aperture **120**.

[0029] The mouthpiece **121** may be formed of a resilient polymeric material (e.g., silicone, thermoplastic polyurethane) capable of creating a conforming seal with the beverage container lid **100**. Optionally, the mouthpiece **121** may be formed of a semi-rigid or rigid material (e.g., polycarbonate, food-grade stainless steel). Precise engineering tolerances may allow such a semi-rigid or rigid material to adequately seal against the drinking aperture **120** and/or drinking aperture walls **130** without the need for a resilient material. Moreover, the mouthpiece **121** may be a monolithic structure comprised of a single material or may be comprised of multiple materials. For example, the sealing portion **129** may be formed of a resilient material while the tip opening **122** may be formed of more rigid material. In the case of a mouthpiece **121** formed of multiple materials, the more resilient material may be co-molded to the more rigid material to improve the durability or ease of manufacturing of the mouthpiece **121**.

[0030] In addition to the drinking aperture **120**, the beverage container lid **100** includes a filling aperture **110**. The filling aperture **110** is an opening in the lid **100** that allows access to the interior of an optional beverage container **200**. The filling aperture **110** is therefore an inlet port to the bottle, and is shaped to allow liquid to be poured therethrough. Accordingly, the filling aperture **110** advantageously allows the beverage container **200** to be refilled without having to remove the beverage container lid **100** from the container **200**. To facilitate faster refilling of the beverage container **200**, the outer periphery of the filling aperture **110** may be larger than the outer periphery of the drinking aperture **120**, as is illustrated in FIGS. **1-3** and FIG. **5**A. In some embodiments, an influent filter or other functional module may be removably or permanently attached to the filling aperture **110** to reduce the level of contamination of liquid flowing therethrough into the beverage container **200** or to provide other advantageous benefits. Non-limiting examples of such filters include mesh filters, carbon filters, activated carbon filters, ceramic filters, and other suitable filters suitable for use as an influent filter. Such an influent filter may be used independently or in conjunction with straw assembly **300** (FIG. **5**C).

[0031] In the frame of reference of FIG. **1**, the filling aperture **110** comprises an upper periphery **112** and a lower periphery **113**. To prevent liquid in the beverage container **200** from escaping through the filling aperture **110** when the cap **111** is in its open position, a one-way valve (e.g., a check valve, not shown) may be removably or permanently connected to the upper periphery **112**, the lower periphery **113**, or between the upper periphery **112** and lower periphery **113** of the filling aperture **110**. Further, the upper periphery **112** of the filling aperture **110** may be larger than the lower periphery **113** to facilitate faster refilling of the beverage container and inhibit liquid from attempting to escape the filling aperture **110** through the upper periphery **112**. Also, as shown in FIG. **3**, the lower periphery **113** of the filling aperture **110** may be smaller than the largest inner periphery of the beverage container lid **100** such that the largest inner periphery of the beverage container lid **100** is spaced from the lower periphery **113**.

[0032] The beverage container lid **110** also includes a cap **111** that covers the filling aperture **110**. The cap **111** can be moved relative to the beverage container lid **100** between an open position and a closed position, to respectively allow or deny access to the filling aperture **110**. In some embodiments, the cap **111** may share hinge **126** and hinge axis **126**A with mouthpiece **121**, as shown in FIG. **1**. In some embodiments, cap **111** does not share hinge **126** with mouthpiece **121**, but can be moved relative to the beverage container lid **100** via a separate hinge and hinge axis. In either embodiment, the cap **111** may be directly or indirectly connected to a hinge to allow the cap **111** to pivot or rotate around the corresponding hinge axis between the open and closed positions, as desired by the user. The hinge **126** allows the mouthpiece **121** to move independently of the cap **111**, if desired. For example, the mouthpiece **121** may be movably connected with the cap **111**, and the cap **111** may be movably connected to the lid **100**.

[0033] The cap **111** may support or carry at least a portion of the mouthpiece **121**. For example, the tip opening **122** or a portion of the bottom surface **121**B of the mouthpiece **121** can rest upon the cap **111** when the mouthpiece **121** is in its closed position. Accordingly, movement of the cap **111** to its open position can correspondingly move the mouthpiece **121**, as is illustrated in FIG. **3**. Optionally, the entire bottom surface **121**B of the mouthpiece **121** may rest upon the cap **111**. In some embodiments, the bottom surface **121**B of the mouthpiece **121** is not supported or carried by the cap **111**, such that movement of the cap **111** from the closed position to the open position does not correspondingly move the mouthpiece **121**.

[0034] The cap **111** may include a rim **111**A that projects from the bottom surface of the cap **111**. The periphery of the rim **111**A extends around the bottom surface of the cap **111** to removably engage either an outer or an inner periphery of the filling aperture **110** when the cap **111** is in the closed position. As is illustrated in FIGS. **1-3** and FIG. **5**A, the rim **111**A may engage the upper periphery **112** of the filling aperture **110** (e.g., when the cap **111** is in the closed position) or disengage the filling aperture **110** (e.g., when the cap **111** is in the open position). The cap **111** may also include at least one vent orifice **170** to facilitate drinking liquid from the beverage container **200** under suction. The vent orifice **170** may comprise a small diameter hole in the cap **111** that is located below a portion of the mouthpiece **121** when the mouthpiece **121** is in the closed position, although the vent orifice **170** may be located in other suitable locations along the cap **111** or elsewhere on the lid **100**.

[0035] The rim **111**A of the cap **111** may form a seal against the filling aperture **110** to prevent leakage of liquid out of the filling aperture **110** or to prohibit contaminants and pollutants from accessing the filling aperture **110**. For example, the rim **111**A of the cap **111** may form a friction fit, o-ring fit, gasket fit, or similar suitable sealing mechanism with the upper periphery **112** of the filling aperture **110** which prevents the cap **111** from opening accidentally. The rim **111**A may also removably engage the upper periphery **112** via a removable snap-fit connection in which at least part of the rim **111**A deflects upon engagement with upper

periphery **112**. Such a snap-fit connection mechanism may provide tactile and/or audible feedback to the user that the cap **111** is in the closed position and thus, that the filling aperture **110** is now sealed. Other suitable connection mechanisms may be used, such as a mechanical interlock between the rim **111**A and filling aperture **110**. Advantageously, the sealing engagement between the cap **111** and the filling aperture **110** offers a degree of leak protection beyond the inclusion of the optional check valve described above.

[0036] FIGS. **1-3** and FIG. **5**A also illustrate that the cap **111** of the beverage container lid **100** may comprise a lip **111**B that extends radially outward relative to the rim **111**A and past the outer lid periphery **101**. Accordingly, the lip **111**B of the cap **111** may either overlay or removably connect to the top lid surface **102**. For example, the lip **111**B may form a removable snap-fit, mechanical interlock, friction fit, or other suitable removable connection with the top lid surface **102**. Advantageously, the protrusion of the lip **111**B past the outer lid periphery **101** makes the lip **111**B an easily identifiable and accessible point that can be used by the user to move the cap **111** between the open and closed positions.

[0037] The cap **111** may also comprise a protective recess **114** on its top surface that removably engages the tip and tip opening **122** of the mouthpiece **121** when the mouthpiece **121** is in the closed position, as seen in FIG. **1**. Accordingly, the mouthpiece **121** advantageously may seal against the protective recess **114** when not in use to prevent any contaminants or pollutants from entering the tip opening **122** of the mouthpiece **121**. Optionally, the protective recess **114** may include a portion which selectively covers a portion of the top surface **121**A of the mouthpiece **121**, to provide additional protection against contamination of the tip opening **122**.

[0038] With reference now to FIG. **5**A, the beverage container lid **100** may also optionally comprise a straw assembly **300** (FIG. **5**C). Straw assembly **300** serves to transfer liquid from the bottom of beverage container **200** to the straw connection portion **160** of the beverage container lid **100** via straw delivery conduit **307**, enabling liquid to be transferred while beverage container **200** is in an upright vertical position. In some embodiments, straw assembly **300** may comprise a straw **301**, a functional module **313**, or both a straw **301** and a functional module **313** (FIG. **5**C). Functional module **313** provides an advantageous benefit as water passes through the module. A combination of straw **301** and functional module **313** can be used to span the distance from the bottom of beverage container **200** to the straw connection portion **160** of the beverage container lid **100**, as shown in FIG. **5**. However, if the height of functional module **313** is tall enough to span that distance, then straw **301** may not be required.

[0039] The straw assembly **300** may be removably connected to the beverage container lid **100** For example, as seen in FIGS. **5**A and **5**B, the straw **301** may include one or more o-rings near the straw top **306** for sealingly engaging the straw connection portion **160** of the beverage container lid **100**. As seen in FIG. **1**, the straw connection portion **160** is defined by a rim that extends downwardly from the beverage container lid **100**. For example, the filter connection portion may be a rim that surrounds the delivery channel **124**. The straw **300** may be removably connected to the straw connection portion **160** of the beverage container lid **100**. In some embodiments, the straw top **306** may be pressed or pushed into the straw connection portion **160** to form a friction fit between the components. Optionally, the straw **301** may include one or more protruding rims near the straw top **306** in place of o-rings **303**A, **303**B that engage corresponding mating recesses in the straw connection portion **160** of the beverage container lid **100** to form a removable mechanical interlock or snap-fit connection. Alternatively, other suitable removable connection mechanisms may be used to removably connect the straw **301** to the beverage container lid **100**. Similar suitable removable connection mechanisms may also be used to directly connect a functional module **313** to the beverage container lid **100**. One or more functional modules **313** may be connected in series. Such modular assemblies may advantageously be interchangeable by the user to carry out different beneficial functions, such as disinfection or the removal of particulates, as discussed below. Optionally, in some embodiments, the beverage container lid **100** may be used without one or more functional modules **313**.

[0040] The straw assembly **300** (FIG. **5**A-C) may include an inlet **302** located on the straw assembly bottom **305** and positioned a spaced distance from the bottom interior surface of the beverage container **200**, as seen in FIG. **5**A. The spaced distance between the beverage container **200** and the straw assembly bottom **305** ensures that a user can draw liquid through the inlet **302**. A support spring **308** may be connected to straw assembly, bottom **305** to make contact with the bottom interior surface of the beverage container **200** and maintain the spaced distance. When the beverage container lid **100**, straw assembly **300**, and beverage container **200** are assembled together, the support spring **308** ensures that all components fit snugly and limits the motion of straw assembly **300**, preventing damage if the assembled beverage container is knocked around or dropped. The support spring **308** may be formed of a material that can be compressed when pressed against the bottom interior surface of beverage container **200**. Support spring **308** may also be formed of a material that allows passage of liquid therethrough, and does not block liquid transfer from beverage container **200** to straw assembly **300**. Precise engineering design and tolerances may allow semi-rigid or rigid materials to adequately function as the support spring. Alternatively, a compressible material may be used such as a sponge, foam, membrane, or non-woven fabric. In some embodiments, a filter assembly or filter unit is a type of functional module.

[0041] The straw assembly bottom **305** may also include a valve **304** (e.g., a one-way valve or check valve) that seats against the straw assembly bottom **305** and against inlet **302**. The valve **304** may be, for example, spring-biased to a closed valve position (see FIG. **5**A) to prevent liquid from entering the straw assembly **300** when the beverage container lid **100** is not in use. User-generated suction at the tip opening **122** of the mouthpiece **121** is sufficient to overcome the valve biasing force and lifts the valve **304** from the straw assembly bottom **305** to allow liquid to enter the straw assembly **300**. Accordingly, liquid may only enter the straw assembly **300** when the beverage container lid **100** is in use (e.g., under suction), and the valve **304** prevents liquid from leaving the straw assembly **300** via the inlet **302**.

[0042] The functional module **313** may also include an outlet **331** located at the functional module top **330** which is in fluid communication with either straw delivery conduit **307** of straw **200** or the delivery channel **124** and/or drinking

aperture **120** of the beverage container lid **100**. The straw assembly bottom **305** may serve as the base of the functional module **313** and may be removably connected to the functional module **313** (e.g., via a removable snap-fit, friction fit, mechanical interlock, or other suitable removable connection mechanism). Alternatively, the straw assembly bottom **305** may be integral or otherwise irremovable from the functional module **313**.

[0043] The functional module **313** may be in fluid communication with the drinking aperture **120** so that liquid is drawn from the beverage container **200** through the functional module **313**, then through the straw **301**, and then through the drinking aperture **120** and tip opening **122** of the mouthpiece **121** upon suction generated by a user. For example, in use, user-generated suction at the tip opening **122** of the mouthpiece **121** may draw liquid through the inlet **302**, through the interior of functional module **313**, through the straw delivery conduit **307**, and through the delivery channel **124**, the drinking aperture **120**, and the mouthpiece **121** to the user. Accordingly, the tip opening **122** of the mouthpiece **121** may be in fluid communication with the inlet **302** when the mouthpiece **121** is in the open position.

[0044] The straw assembly **300**, including the straw **301**, the functional module **313**, the functional module top **330**, straw assembly bottom **305**, valve **304**, and support spring **308** may be formed of a semi-rigid or rigid material. Preferably, the material forming these components is sufficiently durable to withstand both cold and hot temperature liquids (e.g., between temperatures of approximately 0-200° F.) while being sufficiently lightweight to avoid making the combination of the beverage container lid **100** and straw assembly **300** inconveniently heavy. The straw assembly **300** may be formed of polymeric materials such as polycarbonate or metallic materials such as food-grade stainless steel. In addition, the valve **304** may be formed of a resilient polymeric material, or any other polymeric or metallic material capable of seating against the straw assembly bottom **305**. In some embodiments, however, the valve **304** may be a rigid member which seats against a seal or o-ring that is disposed around the inlet **302**. The beverage container **200** may be formed of glass, metal, plastic, or any suitable combination involving one or more of these materials. Optionally, the beverage container **200** may have a double-walled construction.

[0045] In some embodiments, the functional module **313** may be removably connected to the filling aperture **110** and may be used in the same orientation as shown in FIG. **5**A or may also be inverted as compared to the orientation shown in FIG. **5**A. For example, the functional module top **330** may be removably connected to the lower periphery **113** of the filling aperture **110** via a snap-fit, mechanical interlock, friction fit, or other suitable removable connection mechanism. This configuration allows liquid to pass through the functional module **313** upon being poured into the filling aperture **110**. As a result, this configuration enables liquid to be gravity filtered or low pressure filtered, which removes the need for the suction-based mechanism described above.

[0046] Beverage container lid **100** may be provided with different configurations of functional module **313**. Such configurations may advantageously be used to carry out different beneficial functions. Functional module **313** may comprise a filtration module that purifies liquids by removing or eliminating harmful contaminants as the liquid passes through the module. In this embodiment, functional module **313** may contain a filtration media or mechanism, which may comprise a granular filtration media, a pleated or unpleated nonwoven filter media, a filtration membrane, a solid ceramic or carbon block, a disinfection media, an adsorption media, an irradiation source (e.g. an ultraviolet lamp for disinfection), or some combination of these water purification materials and mechanisms.

[0047] Functional module **313** may also comprise a module that enhances or improves the taste and flavor of the liquid as it passes through the module. In this embodiment, functional module **313** may contain a tea or coffee infuser wherein tea or coffee flavors are extracted from tea leaves or coffee grounds as liquid passes through the module. The module may also contain a powdered solid, granular solid, or tablet that slowly dissolves as water passes through the module and imparts flavors, improves taste, enhances mouthfeel, or provides a health benefit (e.g. nutritional supplements or vitamins). Alternatively, the function module **313** may contain a mechanism that adds dissolved gases such as carbon dioxide or nitrogen to the liquid as it passes through the module to provide a carbonated or nitrogenated beverage.

[0048] Functional module **313** may also comprise a module that adjusts the temperature of the liquid as it passes through the module. In this embodiment, functional module **313** may contain an electric heating or cooling element (e.g. a resistive heater or thermoelectric cooling element), or it may contain a latent heat storage unit (e.g. a suitable phase-change material) that can modulate temperature. Alternatively, the module may contain of a reusable freezable gel material or ice block that is placed in a household freezer prior to use with beverage container lid **100** and beverage container **200**.

[0049] Functional module **313** may also comprise a module that contains sensor devices for data collection. Sensors may be placed near the inlet **302** to measure and collect relevant water quality data of liquid contained in the beverage container **200**. Alternatively, sensors may be placed near the outlet **331** in order to collect relevant water quality data of liquid as it exits functional module **313** and is delivered to the user through tip opening **122** of the mouthpiece **121**. Relevant water quality parameters include, but are not limited to: pH, conductivity, total dissolved solids (TDS), alkalinity, turbidity, inorganic chemicals (e.g. lead, chromium, arsenic), and organic chemicals (e.g. disinfection byproducts, perfluorinated compounds, pesticides). Sensor data may be transmitted from the functional module **313** to an external device via wireless technology. Functional module **313** may also be used to collect water usage and consumption data, allowing the user to keep track of their water consumption and meet their individual health or dietary goals. A mechanical or electric counter may be used to record the volume of water that has passes through the functional module **313**. This counter may be used in conjunction with an alarm or a shut-off device that alerts the user or physically blocks liquid from passing through the functional module when the capacity of the functional module has been exhausted.

[0050] Some embodiments of functional module **313** may involve the use of an electric power source or power supply (e.g. ultraviolet disinfection, temperature modulation, sensors). Functional module **313** may contain a small power source, such as a battery or rechargeable battery. Functional module **313** may also optionally include a mechanism for

power generation, such as a flywheel or turbine that rotates as liquid flows through the functional module and generates electricity. This generated power may be directly consumed by other components of the functional module, or may be stored in a battery.

[0051] When functional assembly **313** comprises a filter assembly, the filter housing **309** may comprise one or more filter walls for separating or containing one or more filter media within the filter housing **309**. Specifically, the filter housing **309** may comprise a first filter wall **310**, and a second filter wall **320**. The filter housing **309** may comprise as many filter walls as are necessary for a particular filtration scenario. For example, the filter housing **309** may contain no filter walls if filtration is not desired, or a single filter wall, or five filter walls, or ten filter walls, or twenty filter walls, or fifty filter walls, as dictated by the particular filtration needs. The embodiment illustrated in FIG. **5**A comprises the first and second filter walls **310**, **320**. Each of the filter walls may be removably connected (e.g., snap-fit fit, friction fit, or other suitable connection mechanism) to the interior walls of the filter housing **309** such that the filter walls may be removed entirely from housing for inspection, for cleaning, or to allow for replacement of internal filter components.

[0052] As seen in FIG. **5**A, the filter walls separate the interior of the filter housing **309** into individual filter compartments that may be used to contain filter media. A first filter compartment **312** may be defined by the first filter wall **310** at the top, the straw assembly bottom **305** at the bottom, and the filter housing **309** or the straw assembly bottom **305** on the sides. Similarly, a second filter compartment **322** may be defined by the second filter wall **320** at the top, the first filter wall **310** at the bottom, and on the sides by either the filter housing **309** or a rim extending downward from the second filter wall **320**. Further, a third filter compartment **332** may be defined by the functional module top **330** at the top, the second filter wall. **320** at the bottom, and on the sides by either the filter housing **309** or a rim extending downward from the functional module top **330**. Each filter wall defines an orifice which serves as the outlet from the previous filter compartment and an inlet to the subsequent filter compartment. Accordingly, the first filter wall **310** includes a first filter outlet **311**, and the second filter wall **320** includes a second filter outlet **321**. More or fewer filter compartments may be defined within the filter housing **309** depending on the filtration scenario, and accordingly, more or fewer filter outlets may be included.

[0053] The filter compartments **312**, **322**, **332** each may house at least one filter media or may be empty. Different filter media may be enclosed in each filter compartment, such that the functional module **313** may comprise a layered or suspended combination of filter media, including, for example, adsorption media, electroadsorptive media, disinfection media, size exclusion media, and taste or odor control media, for optimal filtration performance. For example, any of the filter compartments **312**, **322**, or **332** may house an adsorption media capable of adsorbing, binding, remediating, or scavenging environmental contaminants such as toxic anions (including fluoride, arsenite, arsenate, nitrate, chromate, selenite, selenate, etc.), metals, heavy metals or their salts (including lead, mercury, cadmium, zinc, copper, chromium, etc.), volatile organic chemicals, pesticides, herbicides, pharmaceutical chemicals, synthetic or natural organic matters, and the like. Examples of adsorption media include granular filter media, ion exchange resin, metal oxide functionalized resins, anion-selective resins, cation-selective resins, granular activated carbon, kinetic degradation fluxion (KDF), zeolite, metal ion exchange zeolite sorbents, zirconia oxide or hydroxide, natural or synthetic sorbents (including cellulose) or other suitable granular filter media, Components of the adsorption media may include one or more compounds selected from activated carbon, granular activated alumina, granular diatomaceous earth, granular silica gel, granular zeolites, granular silicates, granular synthetic molecular sieves, granular ion exchange resin particles, granular mineral clay, granular aluminosilicates, granular titanates, granular bone char, granular KDF process media, granular iodated resins, granular ceramic, granular perlite, granular sand, granular hybrid of ion exchange resin with metal oxides, granular hybrid of activated carbon with metal oxides, functionalized granular activated carbon, polymeric adsorbent resins, nanofibers or microfibers (including synthetic polymeric nanofiber or microfiber), natural polymeric nanofiber or microfiber, derivatives of natural polymeric nanofiber or microfiber, inorganic nanofiber or microfiber, nanofibrillated fibers, microfibrillated fibers, or any combination thereof. An illustrative adsorption media capable of adsorbing, binding, or scavenging environmental contaminants is the granular filtration media mixture described in published Patent Cooperation Treaty (PCT) patent application WO 2016/025873, published on Feb. 18, 2016, and in U.S. Patent Publication No. US 2017-0239600, published on Aug. 24, 2017, both of Which are incorporated herein by reference. Further, adsorption media may comprise a single layer or mixed layers of filter media or suspended filter media which occupies either an entire filter compartment or only a portion thereof. Optionally, one filter media may be combined with another filter media into a layered or suspended combination within a single filter compartment. The contaminants which can be removed by contact with the adsorption media, include without being limited to: particulate particles, colloidal particles, fine particles, suspended particles, organic, residual halogen such as residual chlorine or residual bromine, selenium, arsenate, arsenite, fluoride, dichromate, manganese, tin, platinum, iron, cobalt, chromate, molybdate, selenite, senelate, uranium, vanadium, vanadate, ruthenium, antimony, molybdenum, tungsten, barium, cerium, lanthanum, zirconium, titanium, and or radium, zinc, copper, lead, mercury, cadmium, as well as natural organic matter (NOM), pesticide and herbicide residues, endocrine disruptors, pharmaceutical residues and organic compounds released through industrial discharges. The particles include without being limited to: particles of lead, copper, iron oxides, ironoxyhydroxide, silica, et al. The contaminated water source includes without being limited to: tap water from municipal supplies or rural wells; municipal water treatment. In some embodiments, the metal contaminants include without being limited to zinc, copper, lead, mercury, cadmium, iron, cobalt, chromate, dichromate, manganese, tin, etc. The contaminant particles from the water source include without being limited to, particulate particles, colloidal particles, fine particles, suspended particles, which widely exist in the contaminated water.

[0054] As a non-limiting example, one filter compartment may include an adsorption composite, a second filter compartment may include a disinfection media, and a third filter compartment may include a size exclusion membrane filter. Any reordering of the filter media is possible, such that

specific filter media arrangements can be achieved in modular fashion within the functional module **313**. In another example, one filter compartment may include the granular filtration media mixture described in WO 2016/025873, a second filter compartment may include a disinfection media, and a third filter compartment may include a size exclusion membrane filter. In another example, one filter compartment may include the granular filtration media mixture described in WO 2016/025873, a second filter compartment may include ion exchange resin filter media, and a third filter compartment may include KDF filter media. Additionally, granular disinfecting media may be used in place of or in addition to any of the filter media discussed above. For example, the first filter compartment **312** may include a disinfection media, the second filter compartment **322** may include a size exclusion membrane disinfecting filter media (e.g., hollow fiber membranes), and the third filter compartment **332** may include ion exchange resin filter media. Any reordering of the filter media is possible, such that specific filter media arrangements can be achieved in modular fashion within the straw assembly **300**. The filter compartments **312**, **322**, or **332** may be of any size suitable to achieve the flow rate and filtration requirements of the straw assembly **300** and may be different in size from one another or may be the same size. Optionally, each filter compartment may have a top screen on a first side and/or a bottom screen on a side opposite the top screen to prevent the filter media from escaping. A filter compartment may have a top screen and a bottom screen, only a top screen, or only a bottom screen, depending on the type of filtration media housed in the filter compartment.

[0055] Disinfection media are used to kill or inactivate or eliminate or trap bacteria, viruses, molds, algae, protozoa, or pathogens. Disinfection media may include the class of compounds known as N-halamines, including halogenated polystyrene hydantoin beads. N-halamines include cyclic amines that have biocidal properties owing to chlorine or bromine or both attached to the amines. Halogenated polystyrene hydantoin beads can be halogenated with chlorine or bromine and may have a varying percentage of crosslinking. Halogenated polystyrene hydantoin beads are disclosed in U.S. Pat. Nos. 7,687,072 and 6,548,054, both of which are incorporated herein expressly by reference. Disinfection media can also include the biocidal polymeric cyclic N-Halamines of U.S. Pat. No. 5,490,983, incorporated herein expressly by reference. However, other disinfection media can be used, such as N-halamines, N-halamine polymers, quaternary ammonium compounds, or iodinated resin. Disinfection media can include HALOPURE brominated media, chlorinated beads, brominated beads, or mixtures of the halogenated beads with adjuvants, such as nanofibers or nanoparticles. Nanoparticles can include nano iron oxides, nano iron oxyhydroxides, nano hydrated ferric oxides (HFO), nano titanium oxides, nano zirconium oxide, nano cerium oxide, nano manganese oxides, nano zinc oxides, nano magnetic iron oxides or any combination of thereof. In some embodiments, the disinfection media can be an electroadsorptive wet laid nonwoven media which traps or removes microorganisms. Combinations of disinfection media can also be used, as described above.

[0056] The disinfection media can optionally include a hybrid particle or composition having polymers linked to nanoparticles that can provide a dual function of water disinfection through biological and chemical contaminants reduction for water purification or remediation. Such hybrid particles are described in PCT patent application WO 2016/061265, published on Apr. 12, 2016, and in U.S. Patent Publication No. US 2017-0240435 A1, published on Aug. 24, 2017, both of which are incorporated herein by reference.

[0057] Additional media that can be used in the filter compartments **312**, **322**, and **332**, alone or in combination with other media, include but are not limited to: activated carbon, ion exchange resin, cyst removal media, and scrubbing media. Activated carbon can remove compounds that would otherwise color the water, or give an unpleasant taste or odor to the water. For example, the activated carbon can remove organic compounds. Activated carbon media can include granular activated carbon, powdered activated carbon, extruded activated carbon (activated carbon with a binder), bead activated carbon, impregnated carbon (activated carbon with a metal, for example), and polymer coated carbon. The activated carbon can be placed in any order in the filter. In some embodiments, the activated carbon follows a pre-filter, when present.

[0058] Ion exchange resin can remove certain ionic compounds from the water through ion exchange. The ion exchange resin may include ion exchange media, such as cation exchange resin that exchanges positively charged ions, anion exchange resin that exchanges negatively charged ions, or amphoteric exchange resin that can exchange both positively and negatively charged resin. The ion exchange resin can be used to remove calcium, magnesium, iron, or manganese from the water. The ion exchange resin can be used to remove nitrates and organic matter from the water. In some embodiments, the ion exchange resin media includes a polymer substrate, such as crosslinked polystyrene. In some embodiments, the ion exchange resin media is porous. In some embodiments, the ion exchange resin media can be in the form of beads or membranes. The ion exchange resin media may include functional groups, such as amino groups, carboxylic acid groups, and sulfonic acid groups. The functional group may depend on the ionic compounds desired to be removed. The ion exchange resin can be placed in any order in the filter. In some embodiments, the ion exchange resin follows the activated carbon. In some embodiments, the ion exchange resin follows the disinfection media.

[0059] Cyst removal media can remove cysts such as *Giardia* and *Cryptosporidium*, or other water borne parasites. In some embodiments, the cyst removal can include cyst removal media, such as a "depth" type filter. In a depth type filter, the materials (e.g., the cysts) to be removed are retained throughout the depth of the filter media and not just on the surface of the media. Depth type fibrous filter media can be, for example, woven, non-woven, wound, spun, melt blown, or resin bonded. Depth type filter media can also include ceramic filters. Other cyst removal media may include membrane filter media. In some embodiments, the cyst removal media can include a pleated filter media. In some embodiments, the cyst removal media can be rated to remove particles to about 1 micron or smaller in size. Further, in some embodiments, the cyst removal filter media can have a pore size of about 1 micron or less. In some embodiments, the filter media for the cyst removal can be a functionalized, reticulated polyurethane foam. In some embodiments, the cyst removal media can be an electroadsorptive wet laid nonwoven media. In some embodiments

where the cyst removal media is used, the cyst removal media can be the last of the filter compartments (e.g., within the filter compartment closest to the tip opening **122** of the mouthpiece **121**).

[0060] Scrubbing media can remove halogens that may be given off by any of the other filtration medias. For example, when the disinfection media uses chlorinated or brominated N-halamines, chlorine or bromine may be released into the water. The scrubbing media is provided to remove the chlorine, bromine, or any other halogen that may be released. The scrubbing media can generally be placed after the disinfection stage or any other media that may release compounds that could affect the quality of the water. In some embodiments, the scrubbing media can be used after the disinfection media, particularly when the disinfection media includes N-halamines. In some embodiments, the scrubbing media can be used after the ion exchange resin media. The scrubbing media can include scrubbing media, such as adsorptive media, including activated carbon or activated carbon block.

[0061] As described above, user-generated suction may be used to draw liquid from the beverage container **200**, through the straw assembly **300**, and through the tip opening **122** of the mouthpiece **121** to the user. For the ease of use of the user, a draw force (e.g., suction force) of between about one half (0.5) pounds per square inch ("psi") to about three (3) psi may be sufficient to draw liquid through the straw assembly **300** and any functional modules therein to the user. In some embodiments, a draw force of less than one half (0.5) psi to about one (1) psi may be sufficient to draw liquid to the user. In some embodiments, a draw force of about three (3) psi to about seven (7) psi may be sufficient to draw liquid to the user. In other embodiments, a draw force of about four (4) psi to about six (6) psi may be sufficient to draw liquid to the user. In an embodiment, a draw force of about three (3) psi may be sufficient to draw liquid to the user.

[0062] Optimal flow rates for user-generated suction to draw liquid from the beverage container **200**, through the functional module **313**, and through the tip opening **122** of the mouthpiece **121** to the user are between about 100 mL/min and 1 L/min. In some embodiments, the functional module **313** may achieve a flow rate of between about 150 mL/min to about 950 mL/min, between about 200 mL/min to about 900 mL/min, between about 250 mL/min to about 850 mL/min, between about 300 mL/min to about 800 mL/min, between about 350 mL/min to about 750 mL/min, between about 400 mL/min to about 700 mL/min, between about 450 mL/min to about 650 mL/min, or between about 500 mL/min to about 600 mL/min, to draw liquid to the user. In a further embodiment, the user-generated suction force is between about one (1) to three (3) psi and the flow rate is between about 200 mL: min to about 800 mL/min. In a further embodiment, the user-generated suction force is about three (3) psi and the flow rate is between about 200 mL/min to 800 mL/min.

[0063] Advantageously, use of granular filter media and granular disinfecting filter media within the filter compartments allows water passing through the functional module **313** to meet or exceed several performance standards. For example, the functional module **313** can meet or exceed the NSF/ANSI 53 or EPA action filtration performance standards for metal contaminant removal when the influent contamination concentration is less than or equal to the concentration stated in the standard for several contaminants, including but not limited to: lead, copper, mercury, arsenic 5^{+}, cadmium, chromium, volatile organic chemicals (VOCs), and pesticides and herbicides. In addition, the functional module **313** can meet or exceed the NSF **401** or EPA action filtration performance standards when the influent contamination concentration is less than or equal to the concentration stated in the standard for Group A, Group B, and Group C contaminants.

[0064] Experiments have been conducted, the results of which indicate the technical advantages of the functional module **313** and enclosed filter media of the beverage container lid **100**. For example, the NSF/ANSI Standard 53 protocol for pH 8.5 lead reduction was conducted using pH 8.5 test water contaminated with 150 parts per billion (ppb) of lead. The pH 8.5 lead test water was pumped through the functional module **313**, with HaloPure AC lead filter media enclosed, at a pressure of about 3 psi to correspond to a draw force sufficient to draw liquid through the functional module **313** to the user, as described above. After filtering between 5-160 (or, e.g., 10-80) L of such highly lead-contaminated influent water, the functional module **313** with HaloPure AC lead filter media advantageously reduced the lead contamination from 150 ppb to between 2 and 7 (e.g., 3-6) ppb and reduced the pH of the water from pH 8.5 to between pH 6.2 and pH 6.8 (or 5.8-6.1), while maintaining a filtration flow rate of between 680 mL/min and 720 (or 345-510) mL/min. Accordingly, in use, the functional module **313** achieves exceptional reduction of metal contamination while sustaining a flow rate that is safely within the optimal flow rate range described above. In some embodiments, the straw assembly includes the functional module **313**.

[0065] FIGS. **6-8** illustrate that the beverage container lid **100** may comprise a utility ring **140**. The utility ring **140** may be rotatably connected to the beverage container lid **100** or the beverage container **200**. The utility ring **140** may rotate from a resting position (see FIG. **6**) to a locking position in which the utility ring **140** sits upon a portion of the cap **111** to lock or hold the cap in the closed position. Optionally, the cap **111** may seal securely against the filling aperture **110**, such that the utility ring **140** is not needed to retain the cap **111** to the beverage container lid **100**. Accordingly, in some embodiments, the utility ring **140** can serve as a convenient carrying handle for the user.

[0066] In the above detailed description, reference is made to the accompanying drawings, which form a part hereof. In the drawings, similar symbols typically identify similar components, unless context dictates otherwise. Thus, in some embodiments, part numbers may be used for similar components in multiple figures, or part numbers may vary depending from figure to figure. The illustrative embodiments described in the detailed description, drawings, and claims are not meant to be limiting. Other embodiments may be utilized, and other changes may be made, without departing from the spirit or scope of the subject matter presented here. It will be readily understood that the aspects of the present disclosure, as generally described herein, and illustrated in the Figures, can be arranged, substituted, combined, and designed in a wide variety of different configurations, all of which are explicitly contemplated and made part of this disclosure.

[0067] The foregoing description details certain embodiments of the systems, devices, and methods disclosed herein. It will be appreciated, however, that no matter how

detailed the foregoing appears in text, the systems, devices, and methods can be practiced in many ways. As is also stated above, it should be noted that the use of particular terminology when describing certain features or aspects of the invention should not be taken to imply that the terminology is being re-defined herein to be restricted to including any specific characteristics of the features or aspects of the technology with which that terminology is associated.

[0068] It will be appreciated by those skilled in the art that various modifications and changes may be made without departing from the scope of the described technology. Such modifications and changes are intended to fall within the scope of the embodiments. It will also be appreciated by those of skill in the art that parts included in one embodiment are interchangeable with other embodiments; one or more parts from a depicted embodiment can be included with other depicted embodiments in any combination. For example, any of the various components described herein and/or depicted in the Figures may be combined, interchanged or excluded from other embodiments.

[0069] With respect to the use of substantially any plural and/or singular terms herein, those having skill in the art can translate from the plural to the singular and/or from the singular to the plural as is appropriate to the context and/or application. The various singular/plural permutations may be expressly set forth herein for sake of clarity.

[0070] It will be understood by those within the art that, in general, terms used herein are generally intended as "open" terms (e.g., the term "including" should be interpreted as "including but not limited to," the term "having" should be interpreted as "having at least," the term "includes" should be interpreted as "includes but is not limited to," etc.). It will be further understood by those within the art that if a specific number of an introduced claim recitation is intended, such an intent will be explicitly recited in the claim, and in the absence of such recitation no such intent is present. However, the use of such phrases should not be construed to imply that the introduction of a claim recitation by the indefinite articles "a" or "an" limits any particular claim containing such introduced claim recitation to embodiments containing only one such recitation, even when the same claim includes the introductory phrases "one or more" or "at least one" and indefinite articles such as "a" or "an" (e.g., "a" and/or "an" should typically be interpreted to mean "at least one" or "one or more"); the same holds true for the use of definite articles used to introduce claim recitations. In addition, even if a specific number of an introduced claim recitation is explicitly recited, those skilled in the art will recognize that such recitation should typically be interpreted to mean at least the recited number (e.g., the bare recitation of "two recitations," without other modifiers, typically means at least two recitations, or two or more recitations).

[0071] In those instances where a convention analogous to "at least one of A, B, and C, etc." is used, in general such a construction is intended in the sense one having skill in the art would understand the convention (e.g., "a system having at least one of A, B, and C" would include but not be limited to systems that have A alone, B alone, C alone, A and B together, A and C together, B and C together, and/or A, B, and C together, etc.). In those instances where a convention analogous to "at least one of A, B, or C, etc." is used, in general such a construction is intended in the sense one having skill in the art would understand the convention (e.g., "a system having at least one of A, B, or C" would include but not be limited to systems that have A alone, B alone, C alone, A and B together, A and C together, B and C together, and/or A, B, and C together, etc.)

[0072] It will be further understood by those within the art that virtually any disjunctive word and/or phrase presenting two or more alternative terms, whether in the description, claims, or drawings, should be understood to contemplate the possibilities of including one of the terms, either of the terms, or both terms. For example, the phrase "A or B" will be understood to include the possibilities of "A" or "B" or "A and B."

[0073] All references cited herein are incorporated herein by reference in their entirety. To the extent publications and patents or patent applications incorporated by reference contradict the disclosure contained in the specification, the specification is intended to supersede and/or take precedence over any such contradictory material.

[0074] The term "comprising" as used herein is synonymous with "including," "containing," or "characterized by," and is inclusive or open-ended and does not exclude additional, unrecited elements or method steps.

[0075] The term "contaminants" can mean chemical contaminants and or biological contaminants from a contaminated fluid. In some embodiments, the biological contaminants include bacteria, virus, fungus, or algae. In some embodiments, the chemical contaminants will include without being limited to: organic compounds, residual halogen, selenium, arsenate, arsenite, fluoride, dichromate, manganese, tin, platinum, iron, cobalt, chromate, molybdate, selenite, selenate, nitrate, phosphate, borate, uranium, vanadium, vanadate, ruthenium, antimony, molybdenum, tungsten, barium, cerium, lanthanum, zirconium, titanium, and or radium, zinc, copper, lead, mercury, cadmium, as well as natural organic matter (NOM, such as tannins, fulvic acid or humic acid), pesticide and herbicide residues, endocrine disruptors, pharmaceutical residues and organic compounds released through industrial discharges.

[0076] The term "contaminated fluid" refers to water or aqueous that contains the chemical or biological contaminants.

[0077] The term "water purification" refers to a process of removing undesirable chemicals, biological contaminants, suspended solids and gases from contaminated water. The objective of this process is to produce water fit for a specific purpose, such as human drinking, or medical, pharmacological, chemical and industrial applications.

[0078] The term "water remediation" refers to a process of removing pollutants from the polluted water or waste water from industrial manufacture processes, or from the polluted municipal or agricultural water sources.

[0079] As used herein, "bead," in singular or plural, can be of any size or shape, including spheres so as to resemble beads, but may also include irregularly shaped particles. "Bead" is used interchangeably with particle.

[0080] As used herein, "hybrid particle" refers to a nanocomposite particle comprising of a polymer with N-halamines or precursor N-halamine, such as polystyrenehydantoin or methylated polystyrene or halogenated polystyrenehydantoin or any methylated polystyrene or any of the halogenated forms of methylated polystyrene or other cyclic amine and N-halamine polymers, and nanoparticles. Hybrid particle can be referred to as a polymeric hybrid particle or as a composition.

[0081] As used herein, "nanoparticles" refers to particles having particle size in the range of 1 to 500 nanometers, preferably, 1 to 200 nanometers, more preferably, 1 to 100 nanometers, such as nano metal particles, or nano metal oxides particles, or others. In some embodiments, nanoparticles are adsorbents. In some embodiments, nanoparticles are linked to polymers, such as the halogenated or nonhalogenated polystyrenehydantoin particles or beads or any of the methylated polystyrenes or other cyclic amine and N-halamine polymers.

[0082] The term "gravity-fed or gravity-flow" filtration refers to the flow of a fluid through a filtration media wherein gravity is substantially the only motive force acting upon the fluid to force the fluid through the filtration media.

[0083] The term "low pressure flow" filtration refers to the flow of a fluid through a filtration media wherein the pressure of fluid within 30 psi or less is the motive force to move the fluid through the filtration media.

[0084] The above description discloses several methods and materials of the present invention. This invention is susceptible to modifications in the methods and materials, as well as alterations in the fabrication methods and equipment. Such modifications will become apparent to those skilled in the art from a consideration of this disclosure or practice of the invention disclosed herein. Consequently, it is not intended that this invention be limited to the specific embodiments disclosed herein, but that it cover all modifications and alternatives coming within the true scope and spirit of the invention as embodied in the attached claims.

1. A liquid container lid, comprising:

a filling aperture configured to allow liquid to enter therethrough; a drinking aperture configured to allow liquid to exit therethrough;

the cap configured to removably sealingly engage the filling aperture; and a mouthpiece hingedly engaged with the cap, the mouthpiece having a tip in selectable fluid communication with the drinking aperture, wherein the mouthpiece is movable relative to the cap from a closed position to an open position.

2. The liquid container lid of claim **1**, wherein the cap is hingedly engaged with the lid.

3. The liquid container lid of claim **1**, wherein opening the cap correspondingly moves the mouthpiece.

4. The liquid container lid of claim **1**, further comprising a container having an opening, wherein the lid and the container are removably attached via a screw fit, snap-fit, friction fit, or mechanical interlock, and wherein the container can be refilled through the filling aperture without removing the container lid from the container.

5. The liquid container lid of claim **1**, the mouthpiece further comprising a bottom opening in fluid communication with the tip.

6. The liquid container lid of claim **1**, wherein the drinking aperture is in fluid communication with a delivery conduit.

7. The liquid container lid of claim **1**, further comprising at least one vent orifice in the cap to facilitate drinking through the mouthpiece.

8. The liquid container lid of claim **1**, further comprising a filter assembly, the filter assembly being removably connected to and in fluid communication with the drinking aperture.

9. The liquid container lid of claim **8**, wherein the filter assembly comprises a housing having an inlet and an outlet, the housing including a housing base and at least one filter wall, wherein at least one filter compartment is defined within the housing.

10. The liquid container lid of claim **9**, wherein the housing base includes a check valve configured to allow liquid to enter the filter assembly under suction generated by a user.

11. The liquid container lid of claim **10**, wherein the filter compartment is configured to house at least one filter media.

12. The liquid container lid of claim **11**, wherein application of user-generated suction to the tip causes the valve to lift and liquid to be drawn through the inlet of the housing, through the at least one filter media in the at least one filter compartment, through the drinking aperture, and subsequently through the mouthpiece to the user.

13. The liquid container lid of claim **1**, further comprising a rim protruding from a bottom surface of the cap and configured to removably engage the filling aperture to secure the cap to the beverage container lid.

14. The liquid container lid of claim **1**, further comprising a utility ring rotatably connected to an outer periphery of the liquid container lid, wherein the utility ring is configured to rotate until it abuts the cap, thereby helping secure the cap to the liquid container lid.

15. The liquid container lid of claim **1**, further comprising a utility ring being pivotally connected to the outer periphery of the liquid container such that the utility ring can pivot from an unlocked position to a locked position in which the utility ring overlies the cap to prevent it from opening.

16. The liquid container lid of claim **1**, wherein the tip of the mouthpiece is engaged by a protective recess in the cap when the mouthpiece is in the closed position.

17. The liquid container lid of claim **1**, the mouthpiece further comprising a protective flap configured to cover the bottom opening of the mouthpiece when the mouthpiece is in the closed position.

18. The liquid container lid of claim **1**, the liquid container lid further comprising a protrusion on a top surface of the mouthpiece, the protrusion configured to assist a user in moving the mouthpiece between the closed and the open position.

19. The liquid container lid of claim **1**, the protrusion further comprising a protective flap configured to cover the bottom opening of the mouthpiece when the mouthpiece is in the closed position.

20. The liquid container lid of claim **1**, the liquid container lid further comprising a protective flap configured to cover the bottom opening of the mouthpiece when the mouthpiece is in the closed position.

21. The liquid container lid of claim **1**, wherein the liquid is water.

22. The liquid container lid of claim **8**, wherein a draw force at the tip of the mouthpiece of between 0.S psi and 3 psi is sufficient to draw liquid through the filter assembly and to the user.

23. A filter assembly for use with a liquid container, the filter assembly comprising: a housing having an inlet and an outlet, the housing including a housing base and at least one filter wall, wherein at least one filter compartment is defined within the housing,

wherein one or more of the inlet and outlet are configured to removably attach to a lid of the liquid container,

wherein the lid of the liquid container is configured to allow a user to draw water through the filter and out of an aperture in the lid of the liquid container,

wherein the filter compartment is configured to house at least one filter media.

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